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SOVIET DEVELOPMENT OF MICROLITE TOOLS

Moscovskiy Komsomolets, 24 May 52 -- Research on metal-cutting processes conducted by Soviet engineers has shown that the life of a cutting tool depends not only on its hardness under ordinary temperatures but, more important, on its hardness under increased temperatures.

In the process of machining metal, the cutting edge of a tool becomes heated as a result of the combined action of deforming force and friction. The degree of heating of a cutting edge (other conditions being equal) is directly proportional to the cutting speed; that is, the higher the speed, the higher the degree of heating.

When the cutter reaches a determined critical temperature (differing for different cutting materials), its edge becomes deformed and the tool goes out of order. It must be noted that the heat ceiling for cutters made of hardened steel does not exceed 250 degrees; for alloy steel cutters, 600 degrees; and for hard alloy cutters, 900 degrees.

The cutting speed depends on the "reserve strength" of the material being cut, under increased temperatures. For this reason, a cutter made of plain or alloy steel does not withstand high-speed conditions.

In an effort to find a more heat-resistant and less expensive cutting material, research was directed toward natural and artificial nonmetallic materials

The technology of sintering metal powders used in the manufacture of hard-alloy tools is called metal-ceramic or powder metallurgy, and the materials obtained by this technology are called metal-ceramics.

In contradistinction to metal-ceramic materials, an artificial stone called microlite, developed at the MKhTI (Moscow Institute of Chemical Technology imeni D. I. Mendeleyev), is a mineral-ceramic material. It is obtained by sintering mineral nonmetallic powders.

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The special characteristics of microlite are its ultrafine and compact grain structure consisting of millions of microscopic crystals, from which it derived its name microcrystallite (mikrokristallit) shortened to microlite (mikrolit).

In 1944, work was begun on obtaining certain special ceramic materials at the Chair of Glass Technology of the MKhTI. In 1948, a sample of this material was tested at the TsNIITMASh (Central Scientific Research Institute of Technology and Machine Building) and showed good metal-cutting possibilities; however, its durability was not too great. As a result of voluminous scientific research, the Chair of Glass Technology succeeded at the beginning of 1950 in obtaining the first samples of ceramic cutters, the quality of which greatly surpassed that of ceramic materials heretofore tested.

In the second half of 1950, a synthetic stone, corundum microlite, which was superior to the first samples, was obtained.

The heat ceiling of cutters made of microlite is more than 1,200 degrees.

Blades made of microlite were used for cutting steel, cast iron, copper, aluminum, and other metals. Tests were conducted at laboratories and plants. They showed that cutters made of the new material will machine not only brittle metals such as cast iron but also ductile metals such as heat-resisting steels.

On 10 April 1952, using microlite blades, P. Bykov, the well-known Stalin prize winner, achieved a cutting speed of 3,200 meters per minute in cutting cast iron. This was a new world's record. It is important to note that the microlite cutter after being in operation for 10 minutes remained unbroken.

In the process of testing, it was established that the durability of new microlite cutters is several times greater than the durability of T15K6 titanium-tungsten alloy cutters. As yet, microlite is inferior to existing hard alloys only in brittleness.

The development of microlite blades has made it possible for the tool industry to obtain inexpensive and readily available material suitable for finish and semi-finish metal cutting and a rapid speed-up in a number of metal-working operations.

The real problem is to develop a method for fastening microlite blades to metal tool shanks.

The Chair of Glass Technology of the MKhTI has been working diligently in this connection. It has sent the first 100 cutters with soldered (glass-cement solder) microlite blades to the Moscow Machine-Tool Plant imeni S. Ordzhonikidze for testing. The first experiments have shown that such a solder is satisfactory. It is expected that multiedge microlite tools will be manufactured in the near future. The chair contemplates putting out new instructions giving special attention to a method of securing microlite to metal. - I. Kitaygorodskiy, Stalin Prize winner, Doctor of Technical Sciences, Professor, Moscow Institute of Chemical Technology imeni M. I. Mendeleyev.

Moscow, Vestnik Mashinostroyeniya, Apr 52 -- Several types of mineral-ceramic tool materials have been developed recently at the VNIIASh MSS (All-Union Scientific Research Institute of Abrasives and Grinding of the Ministry of Machine Tool Building) and MKhTI. The best of these are TsM-332 (MKhTI), and TsV-13, TsV-18, and TsV-44 (VNIIASh).

It should be kept in mind that the blades put out by the above organizations are still lacking in durability, which depends mainly on the closeness of the grain of the blade.

A comparison of the properties of mineral-ceramic materials with those of hard alloys shows that the hard alloys excel the ceramics in bending resistance; the ceramics excel the alloys in hardness and heat-resistance. The lower bending resistance of mineral ceramics should not prevent their introduction into production use even for rough turning of cast iron and steel; however, the danger of crushing the tool when working through the skin of a casting, or when shocks and other irregular load conditions prevail on the cutting edge of the tool, should be taken into account.

On the basis of available experience, several designs of cutters with mineral-ceramic blades have been worked out. These include mechanical fastening of the blade, fastening the blade by the cutting force, and soldered blades. Methods of fastening mineral-ceramic blades differ little from those used to fasten hard-alloy blades.

It should be noted that the cutters with mechanical fastening of blades have considerable advantage over those fastened by cutting force, because in the latter type the sensitivity of the cutter to shock and irregularities of load which take place even under the most favorable cutting conditions is greater.

The blade can also be fastened to the shank by soldering with lead or copper solder or gluing with carbinol glue, water glass, or other adhesive materials. The most promising method is that of soldering developed by the TsNIITMASh, where the technology does not differ in its essential features from the technology of soldering hard-alloy blades. In soldering mineral-ceramic blades, it is necessary only to pay very close attention to the evenness of heating and cooling of the shank and the blade. The soldering is done in gas, oil, or electric furnaces, and also in high-frequency current units which heat up to the melting point of copper or lead solder. Borax is used for flux, and acetone of benzine for washing (degreasing).

At present, as the new tool material is going into the stage of extensive industrial testing, it is not possible to give exhaustive recommendations for cutting conditions; several parameters of the cutting conditions and tool geometry have not yet been tried. For this reason, the available data on cutting conditions must be regarded as provisional; however, it may be applied while new material is being perfected.

Considering the high brittleness of these blades, they should be used under conditions of a rigid "machine-part-tool" system, and cutting where vibration is present should be avoided. These materials should not be used for machining cast iron with chilled skin or steels with hard skin, or for machining parts with abrupt changes in the amount of allowance. Parts that have not been faced must be chamfered first. In view of the high red hardness of the blades, machining can be done without the use of a coolant. However, if the technical specifications call for the use of a coolant in machining a specific part, in view of the insignificant heat conductivity of mineral ceramics, a copious flow of the coolant should be fed to the blade before it cuts into the work.

Green carborundum wheels with ceramic bond are best for sharpening mineral-ceramic tools. Black carborundum wheels can also be used, but their hardness should be 1-2 degrees lower. The recommended speed for the grinding wheel is 6-10 meters per second, with a transverse feed of 0.02-0.03 millimeter /sic/ and a longitudinal feed of 1.0-1.5 meters per minute. There is, however, experimental data indicating that blades can be sharpened successfully with extremely low-speed wheels (0.5-1.5 meters per second) with a plentiful flow of soda-solution coolant. Finishing is done on cast-iron wheels with a boron-carbide paste at a speed of 1.5-2.0 meters per second; the disk is moistened with kerosene.

The field of application of this new cutting-tool material is not limited to machining metals by cutting. There is no doubt that it will find uses in other fields, for example, as a hard-alloy substitute for boring bits, for limit gages, sandblasting nozzles, pressmolds, for reinforcing measuring tools, etc.

The conference convened by the Commission on Machine-Building Technology attached to the Institute of Machine Practice of the Academy of Sciences USSR and the Committee on Cutting and Cutting Tools of the MONITOMASh (Moscow Scientific and Engineering-Technical Society of Machine Builders) has directed that further work on the new cutting tool must be aimed at improving the physical and mechanical characteristics of mineral-ceramic alloys and at their more extensive utilization in the metal-cutting processes.

The conference petitioned the machine-building ministries to have the question considered in their technical councils, to organize large-scale plant tests, and to introduce tools with cutting edges of mineral-ceramics to the ministries' enterprises during 1952.

The objectives of the scientific research institutes and particularly the VNIIASh, the MKhTI, and the VNIITS (All-Union Scientific Research Institute for Hard Alloys) include further broad studies aimed at learning more about mineral-ceramic materials, their successful application in operations where the cutting tool is subject to variable loads or removal of coarse chips, and their suitability for construction materials. Also, certain discrepancies in instructional literature on the subject brought out as a result of research by a number of organizations should be eliminated by further study on a unified method, and consistent instructions should be worked out.

The successful introduction of the new cutting tool into industry will depend not only on the output of mineral-ceramic blades and the publication of the necessary instructions for designing, manufacturing, and exploitation of cutters; but also on the introduction by the ministries of an incentive system for industrial workers who successfully use mineral-ceramic cutting tools in practice instead of high-speed steel and hard-alloy.

The conference expressed the need for convening a third-quarter 1952 All-Union conference for a discussion of experience gained by industry and scientific institutions in the use of mineral-ceramic tools.-- A. M. Karatygin and N. F. Kazakov

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